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ABSTRACT

The objective of this study was to evaluate the effectiveness of the "Groups of Four" program, examining the impact of the cooperative learning strategy on students' achievement in mathematical problem solving. Effects of three specific independent variables in the program were examined in terms of gender, group assignment, and ability, to determine if differences in achievement exist. The historical context of group learning, psycho-social advantages of grouping, and current research are first discussed, with an explanation of the "Groups of Four" strategy. Approximately 150 average ability students from six eighth-grade classrooms participated. In the Experimental 1 group, the strategy was used twice a week; in the Experimental 2 group, the strategy was used on a nonregular basis; the control group had not been trained to use the program. Results of preliminary multiple regression analysis indicated that the amount of time spent in cooperative grouping did not have a significant effect on student achievement. (MNS)

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The Effects of the "Group of Four"
Program on Student Achievement

by

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August 1984

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The Effects of the "Groups of Four" Program on Student Achievement

The objective of the present study is to evaluate the effectiveness of the "Groups of Four" program. More specifically, this study examines the impact of the "Groups of Four" cooperative learning strategy on students' achievement in mathematics problem solving examining several secondary factors. Effects of three specific independent variables in the "Groups of Four" program on postachievement by gender, group assignment and ability are examined. The study determine if differences in achievement exist by gender, group assignment and ability level of the student.

"Groups of Four" is a cooperative learning strategy in which students work together toward the same goal on regular occasions, whereas students in other settings work as individuals or in large groups. The strategy suggests four students to a small group for interaction on problem solving activities.

The instructional system, the means by which information and skills are transmitted to students, is a critical feature of the school organization (Slavin, 1983). All other elements of school organization must ultimately be directed at making the basic instructional system utilized at the classroom level as effective as possible for students (Slavin, 1983, p.1). Viable and research-based delivery systems for teaching

and learning should be studied with increased vigor. Philosophically, educators seek to implement instructional systems or strategies that will promote student learning effectively. Realistically, the economics of current times insist learning must also be efficient. In recent years, there has been a growing interest in the influence of student-to-student interaction through cooperative small group learning. The "Group of Four" instructional strategy (Burns, 1981) builds on the T-group, laboratory, discovery and collaborative learning methods by utilizing in very simple ways what the literature has established about the validity of learning through group interaction (Deutsch, 1949, Bradford, Gibb, & Benne, 1964; Cooper, 1979, Johnson, Johnson & Skon, 1981; Slavin, 1982).

Theoretical Framework Or Perspectives

Historical Context Of Group Learning

Early research into the topic of how people learn best was initiated by psychologists. Kurt Lewin was one of the earliest researchers in the field of group processes from the school of psychology. Lewin found certain methods of group discussion and decisions were superior to lecturing and individual instruction for changing ideas and social conduct. Lewin's studies (1943) supported the idea that learning in groups tends to help individuals conceptualize processes as

they experience them.

Lewin's findings were supported by a number of researchers. Levine and Butler (1952) compared the effectiveness of the lecture method versus group decision in changing the behavior of 395 workers and 29 supervisors in a large manufacturing plant. The study confirmed the findings of Lewin in demonstrating the greater effectiveness of group decision over the lecture method of training.

Psycho-Social Advantages of Cooperative Learning Through Group Dynamics

Significant trends in public education made direct application of group research to improve personal learning and organizational processes. The personal growth goals Lewin popularized through the training or T-group, lay the groundwork for others. Miles (1959), Bradford et al (1964), Schain and Bernis (1965), and Golembiewski and Blumberg (1970, 1977), provide studies which strengthen the position of Lewin and others. Their research emphasizes the importance of interaction for social development and group functioning so important in our society. Arguments for the significance of interpersonal aspects of school life between student-to-student became more and more prevalent in the professional literature during the seventies.

Patton and Giffin (1973, p. 6), suggests that group study is a serious component of education for several

reasons. Small group methods are transferable to other life situations. Small group work also educates the individual to improve the quality of his decision-making by teaching him to be aware of the presence and dynamics of manipulative pressures on his life. The 59th Yearbook of the National Society for the Study of Education, edited by Henry (1960), presents social-psychological theory about classroom groups and proposed ways of fusing psychological theory and research findings to improve instruction.

Current Research

While research on group learning began in the 1900's, classroom applications of cooperative principles began in the 1970's. Several terms have been used to describe the methodology of cooperative learning.

"Student Team Learning" is an extensively researched and widely used method developed by David DeVries, Keith Edwards, Robert Slavin, and their colleagues at Johns Hopkins University (Slavin, 1980). Their programs include "Student Teams-Achievement Divisions" (STAD), "Teams-Games-Tournament (TGT)", and "Jigsaw II." The function of these groups is to prepare its members, through peer tutoring, for participation in a learning-game tournament by rehearsing subject matter presented earlier by the teachers (Sharan, 1980, P. 245). Some of the best-established findings concerning cooperation is that when individuals work together toward a group goal,

they learn to like each other (Deutsch, 1949; Dunn, 1966; Jones & Vroom, 1964). Four studies on STAD (Slavin, 1977, 1979; Slavin, 1980), three on TGT (DeVries & Slavin, 1978); and two on JIGSAW (Gonzales, 1978; 1979), all found positive effects of the Student-Teams-Learning methods on improving relationships between students of different ethnicities.

"Learning Together" is the cooperative learning method closest to pure cooperation designed by Johnson and Johnson (1975). Students work in small groups to complete a single worksheet for which the group receives praise and recognition. The Johnsons and their colleagues have conducted extensive research in the area of cooperative learning and with positive results on a variety of school learning factors. They found that students are most positive about school, subject areas, and teachers or professors when they are structured to work cooperatively (Johnson & Johnson, 1975; Johnson, 1981). Students are more positive about each other when they learn cooperatively than when they learn alone, competitively, or individualistically; regardless of differences in ability, ethnic background, handicapped or not handicapped. (Johnson & Johnson, 1975, 1980, 1981).

The "Group Investigation Model" (Sharan & Sharan, 1976), is the most complex of the cooperative learning methods. Students in small groups take substantial responsibility for deciding what they will learn, how they will organize themselves to learn it, and how they will communicate what they have learned to their classmates. Sharan and others

(1980) found that classrooms were perceived by students as having more positive social climate.

Despite the resurgence of interest on the impact of student-to-student cooperative learning teams, there are discrepancies among findings from research comparing achievement in cooperative and individual settings (Slavin, 1982). Many of the inconsistencies have been explained on the basis of the wide variety in the research designs which focus on different subject matter, settings and measures (Webb, 1982). Talmage and Pascarella (1984) found that achievement gains as a result of cooperative learning strategies may take years to detect. Good and Grouws (1979) found that teachers who taught to groups of students achieved better results than other teachers. They suggest the important question that needs to be answered is what factors are in operation to affect the benefits of small group instruction and which students will benefit the most from the instructional strategy.

"Groups of Four" Operational Definitions

Student-centered "Groups of Four" instructional strategy is basically a method of cooperative learning focused on developing problem-solving abilities while increasing social skills and motivation for learning. It is cooperative learning that requires reorganizing the classroom physically, redefining the students' responsibilities, and carefully

structuring the teacher's role to facilitate acquisition of the method's benefits to students. The program is relatively new and remains unvalidated empirically.

Burns (1981, p. 47) suggests practical operating rules to achieve cooperative learning in the "Groups of Four" program: (1) students are responsible for their own work and behavior; (2) students must be willing to help any group member who asks; and (3) students may only ask for the teacher's help when all four in the group have the same question. These simple rules provide structure for the students and help to keep them on task with the goals of the instructional strategy. The group norms generally develop from the principles of "Groups of Four."

The principles or rules are manageable guidelines for students and have a basis in strong pedagogic reasoning. The first rule reminds students that they will be held accountable for their work even though they may work with a team. Individuals assignments need not be eliminated.

The other two rules encourage the cooperative interaction of the students to benefit of one another. Rule two is designed so that in each foursome, members help each other in their common instructional task and provide individualized instruction of the best variety. Since group productivity facilitates achieving the goal or the teacher's objectives, students are reinforced by helping each other. Webb (1982, p. 423) found "helping behaviors" between students creates a sideways flow of information significant.

to student achievement. Edwards and DeVries, (1972); Johnson, (1979); and Slavin (1978, 1979), provide consistent evidence of a positive relationship between helping behavior and achievement.

The system provides benefits to both teacher and students within the typical classroom setting. The "Groups of Four" design makes regular use of small group instruction feasible for the traditional classroom teacher charged with instructing as many as thirty students at one time. The learning-oriented small group process permits the teacher to divide the traditional class into compact student units providing multiple instructional models.

The role of the teacher is carefully restructured to ensure the effective use of teacher time. Simultaneously, the small group structure has the potential to maximize the active participation of each student and reduce the individual's isolation in the learning process. More students have the opportunity to offer their ideas for reaction and immediate feedback. Social interaction, a needed element for children's learning (Labinowicz, 1972), is a vital part of the strategy's design.

Since the "Groups of Four" process implies participation and involvement, each individual needs to participate in decisions that affect group goals, feel responsibility to and ownership of the group's tasks, and experience a sense of contribution.

Three behaviors characteristic of the "Groups of Four"

program will be utilized in the independent variables of the study. The extent of the group's interaction, evidence of problem solving activities and the observable helping behaviors exhibited by group members.

Organization of "Groups of Four"

Physically, the class is organized into small groups by arranging four desks together or four students at a table. There is no magic in the arrangement of four to a group of students for instruction. There are reasons however, that make four a convenient and useful size for a group. There are enough students to provide for a diversity of ideas, yet not too many to hamper individual participation. The even number allows for partner activities within the group, without the problem of the odd person being left out. The group must be small enough for the individual and personal learning styles to remain intact, large enough to provide for varied student-to-student interaction. Barnes (1977) suggest that students in groups of three to four members is the optimum size for discussion groups of students in the eleven to fifteen age group.

Research questions

The study seeks answers to the question of whether or not student achievement in mathematics problem solving can be

improved through a cooperative learning program such as "Groups of Four," specifically focusing on the behaviors of small group interaction, group members helping behaviors and the extent of problem solving activities evident in the classroom. The study is also interested in whether or not differences in achievement occur by gender, ability level and group assignment.

Data Sources

Approximately 150 average ability students from six eighth grade mathematics classrooms from a Houston suburban school district are participants in this study. The Experimental 1 group consists of two regular classroom teachers and their students utilizing the "Groups of Four" instructional strategy twice a week in class. Experimental 1 teachers have implemented the program twice weekly for the entire school year. Both teachers attended one week of training which modeled the "Groups of Four" strategy for the participating teachers. The Experimental 2 group consists of two teachers and the classrooms in which the instructional strategy has been used throughout the school year on a non-regular basis; once or twice a month. Experimental 2 teachers had received one week of training in the experimental program. The control group in the study consist of two teachers and their students who use the same curriculum and emphasis on problem solving, but had not been trained to use the experimental program.

To assess any significant difference in student achievement due to the "Groups of Four" program, pre-test and post-test achievement scores are utilized in the study. Growth scale value scores are the key data used in the analyses. The pre-test consist of the mathematics problem-solving subtest of the SRA achievement test (Level F) administered at the end of the last school year. The post-test administered in late April on the same SRA achievement indicates the students received approximately eight months of instruction with or without the "Groups of Four" program treatment.

Methods

Multiple regression analysis with dummy vectors are used to represent gender, group assignment and ability level in three stratified groups regressed on dependent variable of postachievement. The three independent behavior variables are utilized as part of the equation to study their effects on the posttest, after controlling for the pretest measure. The vectors for group representing the treatment are compared to the control group. The control group is compared to the treatment groups, then the experimental groups clapsed into one for further comparison of factors.

Preachievement, the strongest predictor of postachievement, group and gender vectors are consistently used as independent variables in the research equation to determine the treatment effect on the specified factors.

Growth scale scores from the problem solving subtest of the SRA standardized achievement test score (level F) are used for both the pre and posttest comparisons. The group variable examines whether or not the cooperative group program, has a statistically significant effect on postachievement by gender, ability, and group assignment.

A teacher questionnaire completed by the six participating teachers was used to score the extent of the factors prevalence in the classroom setting. The information was recorded on a Likert-type five point scale indicating various degrees of implementation.

Data Analysis

Preliminary results of the study indicate that preachievement has a statistically significant effect ($Beta = .64$) on postachievement, but the group measure, the program effect, has a slight insignificant effect ($Beta = -.04$). The two independent variables account for thirty-nine percent of the variance in postachievement.

The three variables of behaviors characteristic of the "Groups of Four" strategy indicate no effect on postachievement. Small group interaction, the only significant variable, was eliminated from the analysis because of strong multicollinearity with the group variable. The group variable was defined in part, by such characteristics.

Table 1
Regression of Preachievement Group and Gender Vectors
Predicting Postachievement

Dependent Variable = Postachievement		
Independent Variables	Beta wt.	T values
Preachievement	.63***	9.53
Group 1	-.05	-.62
Group 2	-.18*	-2.42
Gender (males)	-.01	-.16
RSQ = .42***		
*** p < .001		
** p < .01		
* p < .05		

The results of Table 1 indicate that 42 percent of the variance in postachievement is explained in the equation. As expected, preachievement is a statistically significant predictor (Beta = .63, $p < .001$) of postachievement. The experimental 1 treatment group has a slight negative insignificant effect (Beta = -.05), while the experimental 2 group has significant ($p < .05$) negative effect when it is compared to the control group. A dummy vector for gender representing males reveals that it has a negligible effect (Beta = .01) when contrasted to females, indicating that

gender does not effect postachievement.

Table 2
Regression of Preachievement on Experimental Groups
Stratifying by Gender

Dependent Variable = Postachievement			
		Beta	Beta
Independent Variables	F values/Chow test	Males	Females
Preachievement	.06	.64***	.61***
Group 1	.32	-.11	.02
Group 2	1.06	-.13	-.22@
		RSQ=.38*** RSQ=.48***	
*** p <.001			
**p <.01			
*p <.05			
@p <.10			

Table 2 reports the results of the Chow Test and findings from the regression of preachievement. Even though the Chow Test failed to reveal any significance, groups 1 and 2 are stratified by gender (males and females). Thirty-eight percent of the variance in postachievement is accounted for in the equation for males, forty-eight percent is accounted in the equation for females. The equation for females explains 10 percent more variance in postachievement than the equation for males. The beta weights reflect a

larger preachievement effect for males (.64) than for females (.61). Males for both experimental groups showed negative effect sizes -.11 for group 1 and -.13 for group 2 compared to the control group. Female results indicate a larger discrepancy between group 1 and 2. Females in group 2 had a -.22 effect approaching significance $p < .10$, eleven times that of group 1. The slight minimal effect for females in group 1 is .02. The experimental 2 group has a negative effect for males of .13 compared to the control group while the experimental group 1 reflects negative gains for males -.11. For males, the betas are similarly negative for both groups as compared to the control. The study suggests discrepancies between the two experimental groups, specifically for females. Females using the cooperative grouping on a regular basis did better than females in group two compared to the control group. Experimental group 2 utilizing the treatment only on an infrequent and irregular basis did not improve postachievement for males or females. The program implemented on this basis actually had a negative effect on postachievement. The treatment group 2 teachers, though trained in the program, indicated by their infrequent use of cooperative grouping, that they had no substantive commitment to the program.

Three additional Tables reflect the experimental groups collapsed into one treatment group and compared to the control group. The results of reanalysis by the redefined group regresses preachievement on postachievement by group, gender and then ability. The results are recorded on Tables 3, 4, 5.

Table 3

Regression Equation for Preachievement predicting Postachievement for Collapsed Experimental Group			
Dependent Variable = postachievement			
Independent variables	Beta	T	Value
Preachievement	.62	9.23***	
Group 1	.02	.72	
Gender (males)	.05	.24	
RSQ = .39***			
*** P < .001			
** P < .01			
* P < .05			

Table 3 indicates the equation accounts for 39 percent of the variance (statistically significant at $p < .001$ level). Preachievement has a large effect (Beta = .62, $p < .001$) on

postachievement. The experimental group variable has a small positive effect (Beta = .02) for the treatment group as compared to the control group. The vector for gender (males), shows a small effect (Beta = .05), as compared to females. Neither the group nor gender beta weights are statistically significant.

The results indicate the program has minimal effect for the group and males performed slightly better with the treatment program. No statistical significance exists for the slight standardized regression effects.

Table 4

Regression of Preachievement and Experimental Group on
Postachievement Stratified by Males and Females

Dependent Variable = postachievement			
		Beta	Beta
Independent Variable	FValue/Chow Test	Males	Females
Preachievement	.06	.62***	.62***
Group 1	.32	-.06	.16@
RSQ=.37***RSQ=.46***			
*** p < .001			
** p < .01			
*p < .05			
@p < .10			

Table 4 reports the results of the Chow test and findings from the regression of preachievement and the collapsed treatment group. Although no significant interactions are evident on the basis of the Chow test, the results are examined by stratifying the gender sample. Preachievement has a standardized of .62 $p < .001$ for both males and females. Examination of the beta weights for females indicate a .16 standardized effect which approaches significance. for males, the beta weight for the experimental group is $-.06$. This analysis suggests that cooperative learning may be more beneficial for females than males.

Despite the findings of Table 2, the stratified sample of the grouping by gender suggests that perhaps females do benefit from the treatment more than males. The Beta weight of .16 though not strongly significant, may be meaningful. A comparison of the R-squares indicates that the equation for females accounts for forty-six percent of the variance, while for males the equation accounts for only thirty-seven percent of the variance. The equation for females explains seven percent more of the variance for postachievement.

Table 5
Regression of Preachievement Predicting Postachievement by
Ability

Dependent Variable = Postachievement				
Independent Variable	F Value/Chow Test	Top	Middle	Low
Preachievement	34.04***	.41*	.32**	.46**
Group 1	.00	-.01	-.03	.33*
RSQ=.16* RSQ=.11* RSQ=.36**				
*** p < .001				
** p < .01				
* p < .05				

All three levels are significant and have approximately the same effect on preachievement ranging from .32 at $p < .01$ for the middle group .41, significance level $p < .05$ for the high and .46 $p < .01$ significance for the low ability. The effect of preachievement and group on postachievement stratifying by ability suggests positive differences for the low achievers assigned to the experimental group. The beta weight of .33 ($p < .05$) is over eleven times as large as the middle group with a slight nonsignificant negative (-.03) and the top group with only a negative (-.01) insignificant and negligible effect.

Conclusions

The results of the preliminary multiple regression analysis indicate that the amount of time spent in cooperative grouping does not have a significant effect on student achievement.

A number of conclusions can be drawn from the present study. In this pilot study, the "Groups of Four" cooperative learning strategy did not have a significant effect on student problem-solving achievement. A variety of reasons may exist for these findings. Talmage, Pascarella and Ford (1984), for example, found that student achievement gains resulting from cooperative goal structuring strategies only became apparent after three years of a cooperative grouping project. Their results suggests that it is difficult for

cooperative strategies to affect student achievement in a short period of time. Although the present study suggests cooperative grouping does not impact the achievement of students in mathematics problem-solving, the long term effects of this intervention may uncover achievement gains.

The second and third equation analysis reflects the discrepancy between the benefits to students by gender. This effect may be the product of the class environment or group dynamics within the treatment classrooms. The teacher's behavior for setting the climate may also be a factor in the different classes. The results are not conclusive.

One of the limitations of the study is the arbitrary grouping of teachers into groups based on their use of the model. The Experimental group used the model five times a month as recorded on the questionnaire. Experimental 2 group teachers used cooperative grouping considerably less often. Although trained, these teacher may not have a commitment to the use of cooperative grouping in the classroom. The additional regression equations were run to alleviate this problem. Achievement gains from its use once or twice a month is unlikely. Results may have been significant with the group 1 treatment group compared to the group 2 treatment and control as a collapsed unit. The three groups and even the two group comparisons of experimental and control group may not have been characteristic of the operational definitions assigned to them.

Talmage, Pascarella and Ford (1984) also indicate that

long-term inservice programs are necessary to sustain its productive use in the classroom. Teacher training in the present study was of one week duration with little or no follow-up.

Another limitation of the study may be the use of standardized achievement data which might assess problem solving skills in the methodological sense, but often fail to assess higher level of thinking skills associated with group problem solving (Spivack and Shure 1974).

A study of longer duration with teachers and classrooms associated with a strong degree of experience with cooperative learning groups would be preferable in terms of delineation of instructional models.

Educational Or Scientific Importance Of The Study

Research suggests that classrooms in our schools are among the institutions least characterized by cooperation among peers (Johnson and Johnson, 1981, 1982). On the other hand, it is a characteristic very necessary for success in the adult world of work. Johnson (1982) suggests that classrooms are basically competitive in nature. The problems of the competitive classroom, especially for the low achieving students has been discussed for years with few practical solutions. While research on cooperation began in the 1900's (Johnson & Johnson, 1975; Slavin, 1977), research on practical classroom applications of cooperative principles

began in the 1970's. "Groups of Four" (Burns, 1981) is a practical instructional strategy which may facilitate problem solving for students. The influence of student-to-student interaction, a free resource to the schools, should no longer be ignored within the school setting (Johnson, 1982). Research has found that a positive relationship exist between achievement and small group interaction teams (Johnson, 1979, 1980, 1981; Slavin, 1977, 1981; Sharan, 1980). Despite design flaws indicated by Slavin, (1983), a recent meta-analysis (Johnson, Maruyama, Johnson, Nelson and Skon, 1981), which includes 122 studies concludes that cooperative learning has positive benefits for students.

The characteristics that exist between the individuals in the group, the group as a functioning unit, the setting and achievement is worthy of further study. Cooperative grouping involves management skills on the part of both teachers and students. As teachers become more familiar with cooperative grouping and learn to increase its productivity by including it in their regular instructional repertoire, achievement gains may become apparent. The value of knowing the type of student that will benefit the most from the cooperative grouping experience will help educators to use the strategy more effectively for those students.

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